

**REMARKS**

This is in full and timely response to the above-identified Office Action. The above listing of the claims supersedes any previous listing. Favorable reexamination and reconsideration are respectfully requested in view of the preceding amendments and the following remarks.

**Election/Restrictions**

The finality of the election requirement is noted.

**Claim Rejection 35 USC - §§ 102/103**

Claims 46-49 are rejected under 35 U.S.C 102(b) or 102 (e) as anticipated by or, in the alternative, under 35 U.S.C. 103 (a) as obvious over Fischer (US-810) or Chisholm et al (US-068). This rejection is respectfully traversed.

In this rejection, US 4,645,810 to Fischer is advanced as disclosing and exemplifying an adhesive composition derived from 100 parts of monofunctional methacrylate (a), 50-200 parts of hydroxymethacrylate (b), and not more than 20 parts of a dimethacrylate (c). Prior art (a) and (b) are within the scope of the instant A monomer and prior art (c) is within the scope of the instant B monomer as claimed (col.3, lines 23-67; working example). Thus the claims are alleged to be anticipated.

US patent 4,645,810 to Fischer discloses a method of forming an adhesive bond between the substrates out of which one comprises zinc. Some of the monomers included in cited patent and the instant application are same. However, the course of polymerization and properties of final products in the two cases are completely different.

In Fisher, the dimethacrylate monomers are used as crosslinking agents to induce higher bond strength in adhesive composition (Col 3, line 33-36). **This can be achieved only when both double bonds in the diacrylate monomer react and the final product is crosslinked.**

In contrast the objective of the claimed subject matter is to disclose a method to control the polymerization of **multivinyl monomer in such a way that only one of the vinyl unsaturation of multivinyl monomer undergoes polymerization reaction**. The instant application describes selective polymerization of multivinyl monomers, carried out by protecting the vinyl groups from polymerization by forming inclusion complex with cyclodextrin or its derivative in stoichiometric proportion e.g. for a divinyl monomer such as ethylene glycol dimethacrylate, the molar ratio of

divinyl monomer to cyclodextrin is 1:1 while in case of trivinyl monomer such as trimethylolpropane trimethacrylate the ratio is 1:2.

Thus, in case of ethylene glycol dimethacrylate: cyclodextrin complex, one of the vinyl groups is included in the cavity of cyclodextrin and other vinyl group is free to react. In case of trimethylolpropane trimethacrylate: cyclodextrin complex two vinyl groups are included in the cavity of cyclodextrin and only one vinyl group is free to react. Thus in case of divinyl and trivinyl monomers, only one vinyl group is free to react with other comonomer. The inclusion complex when copolymerized with other monovinyl comonomers undergoes selective polymerization with the vinyl group, which is outside the cavity of cyclodextrin and the polymerization proceeds without crosslinking.

US patent 6,646,068 to Chisholm et al. is cited as disclosing and exemplifying soluble branched copolymer suitably used as surface coating, comprising a monofunctional monomer and 0.3-100 w/w% of a polyfunctional monomer defined within the scope of applicant's A and B monomers (col. 2, lines 13-25; col. 3, line 7 to col. 4, line 37; working examples).

Chisholm et al. discloses a soluble branched polymer composition and method to obtain the same by polymerizing monofunctional monomers and polyfunctional monomers in the presence of moderate amounts of chain transfer agent. The use of chain transfer agent during the copolymerization controls the cross-linking reactions and results in the formation of branched polymers. The cross-linked polymers and branched polymers differ from each other in the structure and hence in properties and performance.

The use of moderate amount of chain transfer agent during the polymerization of polyfunctional monomers inhibits cross-linking and yields branched polymers. During polymerization of monofunctional and polyfunctional monomers, branching occurs because of the chain transfer at early stage of polymerization and the reaction between the pendant unsaturations formed and growing polymer radical. Thus all unsaturations in the polyfunctional monomer take part in polymerization.

In contrast the claimed copolymer composition contains polyfunctional monomers bearing multiple vinyl groups, of which only one takes part in the polymerization. This selective polymerization is a result of the formation of an inclusion complex wherein the unsaturated site is included in the cyclodextrin cavity and hence does not take part in polymerization. Thus, the copolymer obtained by us is **soluble in organic solvent** and comprises the pendant **unreacted vinyl unsaturations in polymer structure**. This is not the case with Chisholm patent US 6,646,068.

Regarding the recited "only one unsaturated site has taken part in polymerization" pertaining to monomer B, the examiner takes the position that such characteristics is considered inherent in prior art polymerization process, or at the least would be expected to occur to a certain extent. The Examiner further advances that the burden is placed upon the applicant to provide clear evidence that the respective compositions do in fact differ. In any event, it would have been obvious to one having ordinary skill in the art to control the relative reactive ratios of various monomer components so as to obtain a copolymer product with the desirable recurring units and architecture.

In rebuttal, the applicant would like to reiterate that the characteristics, "only one unsaturated site has taken part in polymerization" pertaining to monomer B is not inherent in prior art polymerization. In the polymerization of multivinyl monomers by free radical polymerization, it has not been possible until now to selectively polymerize only one of the vinyl groups. As a result, the polymerization involving multivinyl monomers leads to crosslinked products as has been reported in the US patent 4,645,810 to Fischer and US 6,646,068 to Chisholm et al. cited by the examiner.

Polymerization of multivinyl monomers in the presence of chain transfer agents at high concentration leads to polymers soluble in organic solvents (US 6,646,068 to Chisholm et al.) But this is because all unsaturated sites have taken part in the reaction leading to branching. Thus, in the case of cited patent although the product is soluble, this is not because of selective polymerization of the multivinyl monomers.

The applicant points out that the objective of the invention is not to control the relative reactivity ratios of various monomer components. Variation of composition does not control reactivity in the present case. The reactivity is controlled by blocking the reactivity of the vinyl group which is included in the cyclodextrin cavity. The stoichiometry of the inclusion complex is well defined.

The polymers of the claimed invention are produced by copolymerization of monofunctional vinyl monomer A and polyfunctional vinyl monomer B. The unsaturated sites in B have been protected by forming an inclusion complex with cyclodextrin to obtain the soluble polymers comprising pendant vinyl unsaturations. This is also demonstrated in the comparative example (example No. 3) wherein the use of polyfunctional vinyl monomers without formation of inclusion complex with cyclodextrin leads to crosslinked products, which are not soluble in any solvent. The approach to control the reactivity of polyfunctional vinyl monomers by protecting all but one vinyl

groups using cyclodextrin host-guest chemistry and thus the polymerization of only one of the unsaturated sites during copolymerization is neither disclosed in nor suggested by the prior art.

The properties and structure of polymers synthesized by the Applicant's methodology are distinctly different from those disclosed in the cited patents (US 4,645,810 and US 6,646,068). It is therefore submitted that this provides a clear showing that the compositions of the claimed invention are different than those cited by the Examiner (Viz., US 4,645,810 and US 6,646,068).

### **Claim Rejections – 35 USC § 103**

The rejection of claims 46-49 are rejected under U.S. C. 103(a) as being unpatentable over Blackwell (US-559) or Attarwala et al. (US-320) is respectfully traversed.

US 5,756,559 to Blackwell et al. cited in this rejection as disclosing an adhesive composition comprising at least one polymerizable acrylate compound (col. 3, lines 4-21), including one or more monofunctional or polyfunctional acrylate monomers (col. 5, line 38 to col. 6, line 54; col. 8, lines 30-34) defined within the scope of the present claims.

Similarly, US 6,727,320 to Attarwala et al. is cited as disclosing an adhesive/ sealant composition. Suitable polymerizable monomers include mixture of monofunctional and polyfunctional (meth) acrylate monomers taught within the scope of the instant claims (col. 4, line 64 to col. 6, line 46).

US 5,756,559 to Blackwell et al. and US 6,727,320 to Attarwala et al. use the monofunctional and polyfunctional monomers to yield dental composition having high bond strength (12 MPa) and the adhesive or sealant composition for the thread locking and sealing applications respectively. To ensure the higher bond strength as well as the good adhesive and sealant properties it is imperative that the polymerization in these systems leads to crosslinked products.

Suppressing the reactivity of the monomers containing multiple vinyl groups would defeat the end objective in these cases. Whereas with the claimed subject matter, the copolymerization is carried out by forming an inclusion complex of monomer B i.e. polyfunctional vinyl monomer with cyclodextrin which inhibits/protects the reactivity of included vinyl unsaturations with growing polymer radical and thus the monomer B will react with only one vinyl unsaturation though it comprises multiple unsaturations. Removal/de-complexation of inclusion complex, yield solvent soluble linear polymers containing pendent unsaturations in the polymer. Thus, the main objective of using the polyfunctional monomers and the end properties in this application is different from what has been cited in the patents (US 5,756,559 and US 6,727,320).

The rejection advances that, since the prior art disclosed above teach copolymer systems derived from mixture of monofunctional and polyfunctional monomers as expressed in the present claims. Accordingly, one having ordinary skill in the art would have readily envisaged selecting a mixture of monofunctional and polyfunctional ethylenically unsaturated monomers as taught to be functional/ operational in the preparation of prior art copolymer, motivated by the reasonable expectation of success in making adhesive composition. Thus, rendering obvious the present claims.

The prior art cited by the examiner teaches copolymer systems comprising monofunctional and polyfunctional vinyl monomers, which lead to crosslinked polymers. However, it does not teach how the unsaturated groups which intrinsically have the same reactivity can be selectively polymerized as to yield polymers which are soluble in organic solvents and contain pendant unsaturated groups, which can be polymerized in a subsequent step to obtain cross-linked products. The purpose of using the multivinyl monomers as well as the structure of final products in the patents cited by the examiner are totally different from the copolymer disclosed in our patent application. Further the prior art demonstrates the use of polyfunctional monomers to achieve high bond strength (Fischer et al US), branched polymer architectures (Chisholm et al, US 6,646,068), dental composition with high bond strength upto 12 MPa (Blackwell et al. US 5,756,559) or adhesive or sealant composition (Attarwala et al US 6,727,320).

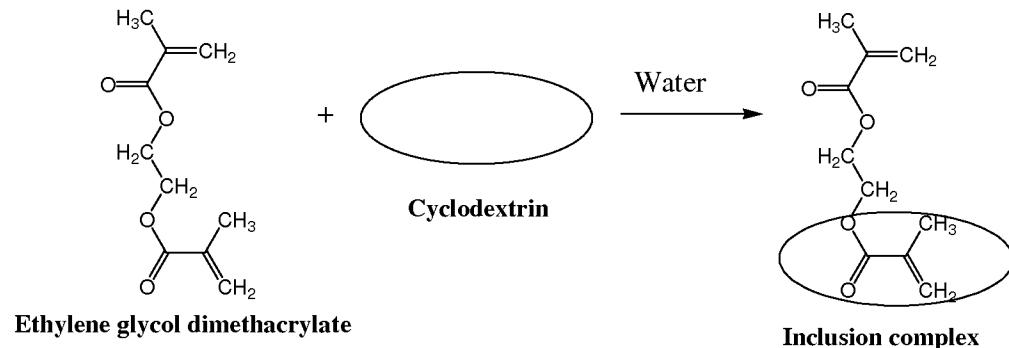
Thus in **all the cited references** the polyfunctional monomers are required to undergo the polymerization reaction using all double bonds to impart the **high cross-link density** and thus fulfilling the needs in the desired applications. In contrast **the claimed subject matter** discloses a method whereby it is possible to control the reactivity of multivinyl monomers via inclusion complex formation with cyclodextrin to yield **un-crosslinked soluble copolymers containing pendant vinyl unsaturations**. The products of the present invention, the polymers containing latent unsaturation achieved by a single step synthetic process, extend the scope of applications to areas where the cross-linked/ branched polymers of the invention cited by the examiner can not be used.

The differences in the approach in our applications vs the patents cited by the examiner are schematically highlighted below.

**Schematic representation of the invention**

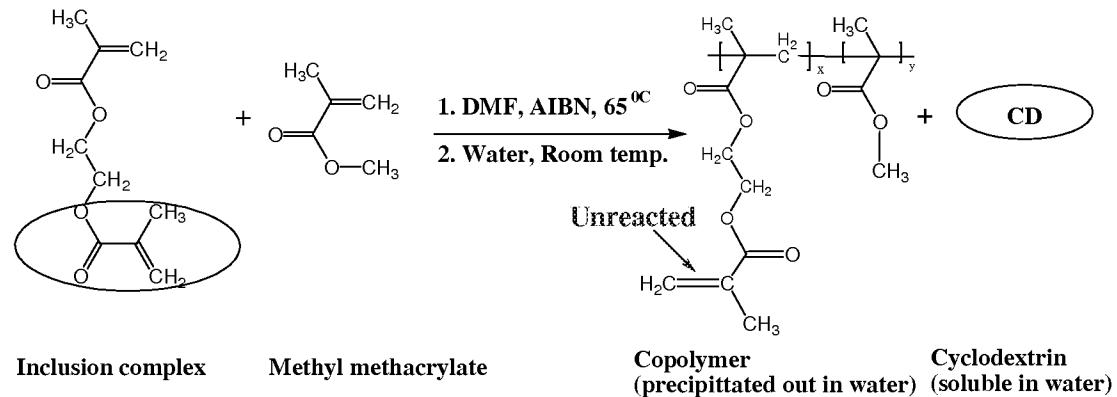
**Copolymerization of Ethylene glycol dimethacrylate- $\beta$ -cyclodextrin inclusion complex with methyl methacrylate.**

**Step 1. Inclusion complex formation**



Cyclodextrin formed 1:1 inclusion complex with ethylene glycol dimethacrylate. In this, one of the vinyl unsaturations of divinyl monomer is included in the cyclodextrin cavity and only one of unsaturated site is free for the polymerization.

**Step 2. Copolymerization**



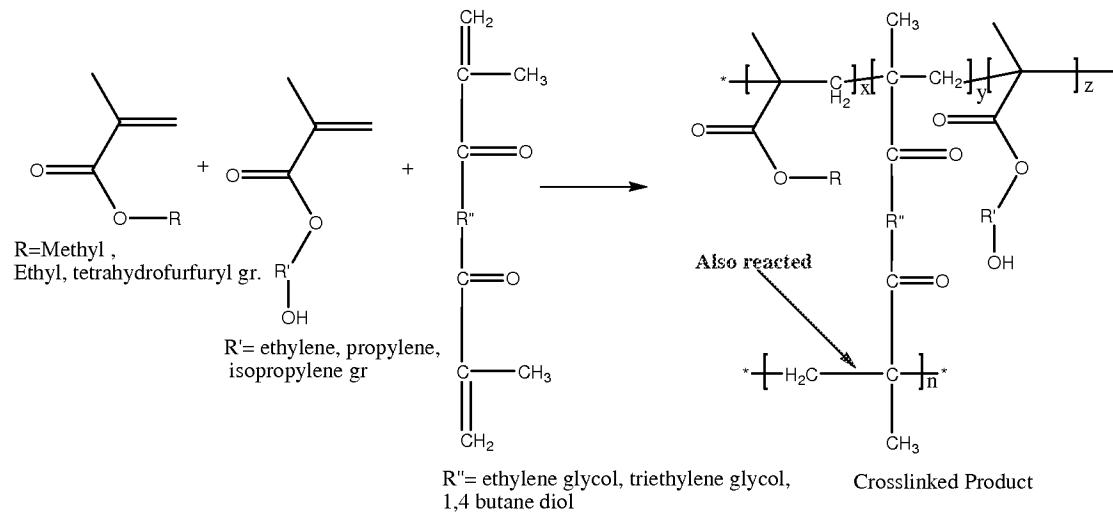
Polymerization of divinyl monomer included in cyclodextrin cavity was carried out in *N,N'* dimethyl formamide in presence of polymerization initiator. The polymer was precipitated in water. The copolymer comprising monovinyl monomer (methyl methacrylate) and divinyl monomer (ethylene glycol dimethacrylate) which has reacted with only one of its vinyl unsaturation was obtained as precipitate while cyclodextrin remained dissolved in water. The copolymers are soluble in common organic solvents for poly (methyl methacrylate) i.e. tetrahydrofuran, chloroform, methyl ethyl ketone, *N,N'* dimethyl formamide, dimethyl sulphoxide

etc.

Similarly, the selective copolymerization other polyfunctional vinyl monomers and monofunctional vinyl monomers was carried out by protecting all but one vinyl unsaturations of polyfunctional vinyl monomers during polymerization to yield soluble polymers comprising pendant unsaturations.

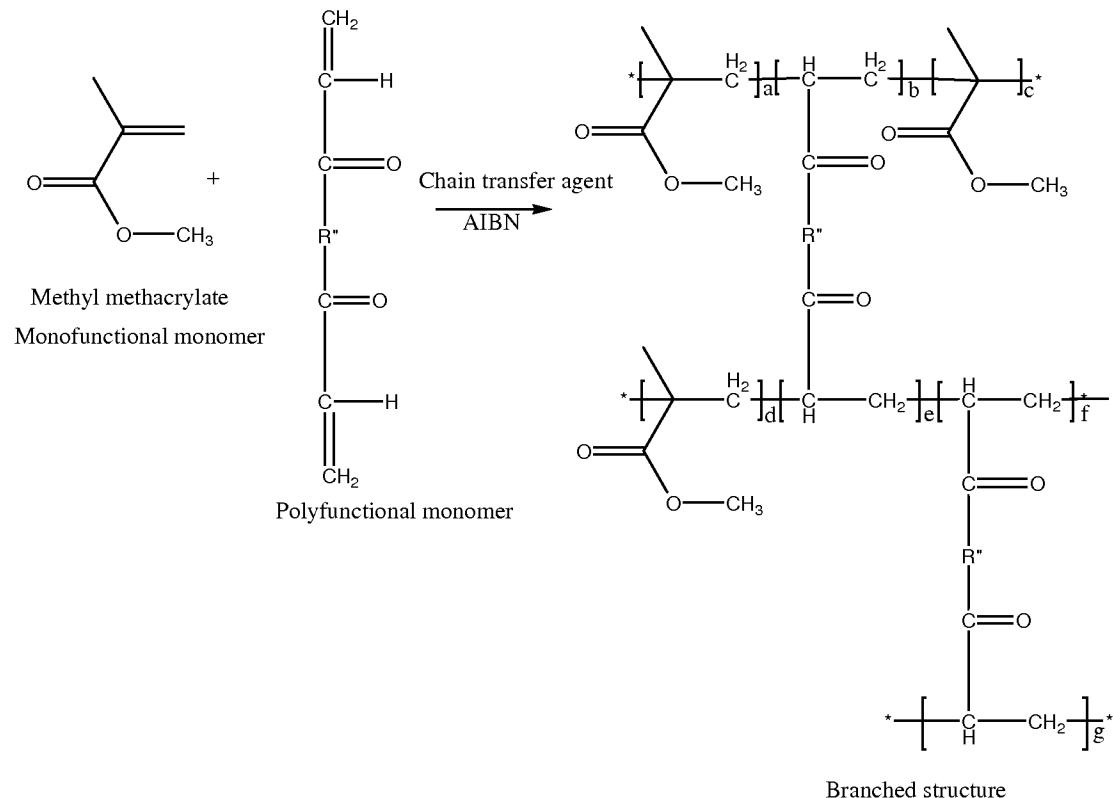
**Schematic representation of art cited by the examiner**

**1. Fischer US 4,645,810**



Both the double bonds of dimethacrylate were reacted to yield cross-linked product to achieve higher bond strength.

## 2. Chisholm et al US 6,646,068 B2



Use of chain transfer agent during polymerization yielded branched structure using all the double bonds of polyfunctional monomer.

The schematics above shows how the polymer structures resulting from the patents cited by the examiner and that which results from the claimed subject matter, are different.

It is therefore submitted that claims 46-53 should be allowed in light of the preceding arguments.

All objections and rejections having been addressed, it is respectfully submitted that the present application should be in condition for allowance and a Notice to that effect is earnestly solicited. An Early issuance of a Notice of Allowance is courteously solicited.

The Examiner is invited to telephone the undersigned, Applicant's attorney of record, to facilitate advancement of the present application.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 07-1337 and please credit any excess fees to such deposit account.

Respectfully submitted,  
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